Norwegian Biology, Medicine and Psychology Undergraduate Students´ Acceptance of Modern Evolutionary Theory Using the I-SEA Survey Instrument

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Note on Abbreviations of Terms

Modern Evolutionary Theory = MET
Evolutionary Biology = EB
Evolutionary Medicine = EM
Evolutionary Psychology = EP

University of Oslo = UiO
University of Bergen = UiB
Norwegian University of Science and Technology = NTNU
University of Tromsø = UiT

Inventory for Student Evolution Acceptance=I-SEA

Creationism = C
Intelligent Design = ID

Abstract

584 undergraduate students from three disciplines and four public universities in Norway were sampled during the spring of 2014 for acceptance of modern evolutionary theory using the I-SEA survey instrument developed by Nadelson and Southerland (2012). Using a scale from one to five where five signals strong agreement with modern evolutionary theory, overall acceptance was 4.49. Differences where found between majors of biology, medicine and psychology, though all the differences were small (as indicated by Cohen´s *d*). A small effect of taking an evolution course on acceptance rates was found. These results are discussed within the framework of understanding why there are different levels of acceptance between countries, teaching modern evolutionary theory in the classroom and differences in acceptance between academic disciplines. Norway and other Nordic countries have high levels of acceptance of evolution compared to many other Western countries. Studies show that countries with high levels of science literacy, GDP and school-life expectancy, and with low levels of religiosity have the highest acceptance rates. While biology majors are familiar with evolutionary theory in their syllabus and required readings, studies show that majors in medicine and psychology are much less familiar with Darwin´s theory of evolution by natural selection. Students and staff reject evolutionary theory for cognitive, methodological, coherence and emotional reasons. In a Chapter 2 review arguments in favor of why biology, medicine and psychology should incorporate modern evolutionary theory are put forth, as well as to expand upon why students and staff reject evolutionary theory, and how to persuade students to accept it. Modern evolutionary theory has a lot to offer biology, medicine and psychology in terms of establishing a casually unifying framework that unites all disciplines dealing with living organisms and their complex adaptations. A major concern of science educators is how to effectively teach modern evolutionary theory to students, especially those with a religious background. Some useful, practical tips and suggestions are discussed.

Chapter 1

1. Introduction

1.1 The Status of Modern Evolutionary Theory

The year 2009 marked the bicentennial of Darwin´s birth, and 150 years since the publication of his landmark book *On the Origin of Species*. To celebrate this event, several volumes were published to honor Darwin´s legacy. Two of those books were *Evolution: The First Four Billion Years* (Travis and Ruse, 2009), and *Darwin: Verden Ble Ikke Den Samme* (Hessen *et al*., 2009). The contributions of those two books are a testament to how far ranging and applicable Darwin´s theory of natural selection is to humans. There are entries on evolutionary perspectives of religion, history, anthropology, culture and society, language, philosophy, medicine and psychology. The last two perspectives, named evolutionary medicine, and evolutionary psychology grew arguably out of the discipline E.O. Wilson created in 1975 with the publication of his monumental synthesis *Sociobiology* (1975).

When Wilson´s book came out, he got a lot of pushback from other academics, including Stephen Jay Gould and Richard Lewontin. Stephen Gould, a famous American paleontologist and Richard Lewontin, a University of Chicago evolutionary geneticist were two of the fiercest critics of an evolutionary approach to human mind and behavior, especially EP. Even today not everybody accepts EP or EM as legitimate scientific disciplines. Its critics see these disciplines as misinformed, irrelevant, or flat out wrong (Rose and Rose, 2000; Hessen *et al*., 2009). Many critics of EP see EP as wrong because it is not up to scientific standards, or they do not see what EP can offer of insights or predictions (Kennair, 2004; Hessen *et al*., 2009).

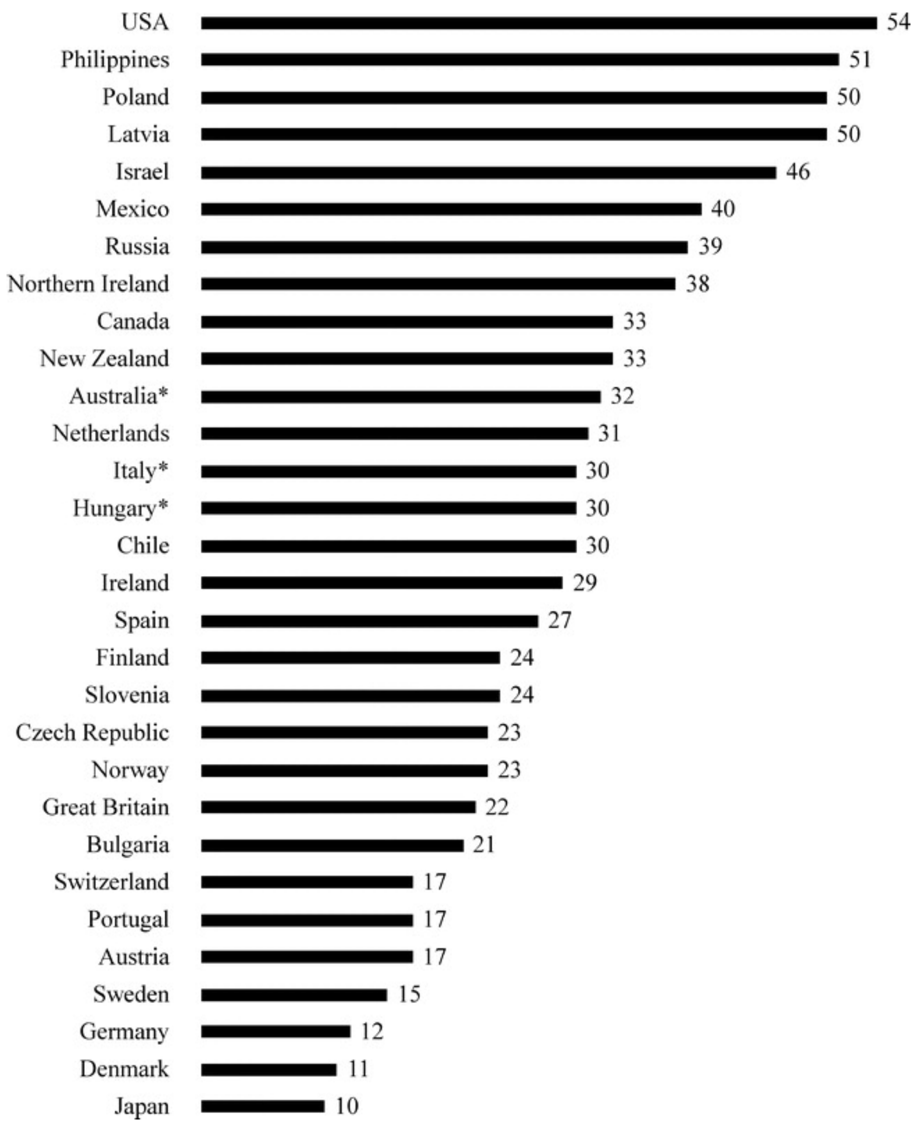

Figure 1. Percentage of national populations not believing that humans evolved from an earlier species, descending order. Data are from the International Social Survey Programme (ISSP) for 2000, except where an evolution question was not asked in that year; for these nations, starred, ISSP 1993 results are shown. Taken from Mazur, 2005.

On a national level, countries vary in their acceptance of modern evolutionary theory, where Norway usually has high levels of acceptance, while countries like Turkey and the United States, have not (Fig. 1).

The teaching of those two disciplines has not fared much better in university classrooms, either. Very few universities have comprehensive coverage of EP in psychology textbooks, and EM textbooks have relatively sparse coverage of the full range of topics covered by EM. In addition, few university programs offer courses in

EP or EM and at least when it comes to EP, if they do it is almost always as an elective course.

But EP has a lot to offer psychology students in terms of insight into the deeper reasons for psychological phenomenon, and it can even unearth previously undiscovered phenomena. The same goes for EM. To a lesser extent, evolutionary theory has been applied to certain aspects of medicinal practice, most noticeable to the use of antibiotics, but a comprehensive coverage of the full range of topics covered by EM is still missing.

Except for publications in the journal *Tidsskrift for Den Norske Lægeforening* about EM, and integration of some parts of EM in some medicine textbooks, a systematic introduction of EM to students of medicine in Norway is missing, and it appears that articles documenting the state of EM course offerings in Norway are largely absent (Mysterud, 1998). EP is taught as a course at the NTNU, but seems to be largely absent from the other public universities.

1.2 Modern Evolutionary Theory and Its Discontents

At least three groups of opposition can be deciphered: religious opposition, political and social opposition, and secular academic opposition (Kennair, 2004). For various reasons these three groups go against Darwinian theory in general, and Darwinian theory applied to humans in particular.

Table 1. Types of organized religious opposition to modern evolutionary theory compared to Naturalistic Evolution.

Name	Description	Age of Earth	Involvement of God	Accepts modern evolutionary theory
Young Earth Creationism	The biblical story is literally true. No species evolve, or have died out.	6000-10 000 years	Yes	No
Old Earth Creationism	The biblical story is on the whole correct, but certain aspects of it are in line with modern science.	4,5 billion years	Yes	Partially
Intelligent Design (ID)	Purports to be a scientific theory where its main claim is that an Intelligent Designer designed humans and all other living things.	4,5 billion years	Yes[1]	Partially
Theistic Evolution	A God guides evolution, with special attention to humans.	4,5 billion years	Yes	Yes[2]
Naturalistic Evolution	Scientific evolution without the aid of a God or an Intelligent Designer.	4,5 billion years	No	Yes

[1] Proponents of Intelligent Design (ID) rarely, or never say that the Intelligent Designer is God, or a God, or the Christian God, though it is quite clear from their writing that they mean the Christian God. [2] Proponents of Theistic Evolution accepts everything that modern science says about modern evolutionary theory, with the added addition of a God that guides the evolutionary process (with special attention to humans). Table based upon Hessen *et al.*, 2009.

One of those three groups is religious opposition, which has opposed the theory since Darwin´s time. In the US, as well as many other countries including Norway, there are several different forms of religious strands of opposition to Darwinism (Table 1). C, later turned ID is strong in the US, but not in Norway. However, it is important to note that despite not being very prominent, there are organizations and individuals in Norway that seek to undermine evolutionary theory in schools (Hessen *et al*., 2009). Private schools are free to teach what they want, and science educators are worried that C or ID will be smuggled into biology and general science classrooms. But even in public school classrooms, evolutionary theory does not have its rightful place in the biology or the general science curriculum, and human evolution gets very little attention in Norway (Hessen *et al*., 2009; Kjetland *et al*., 2015).

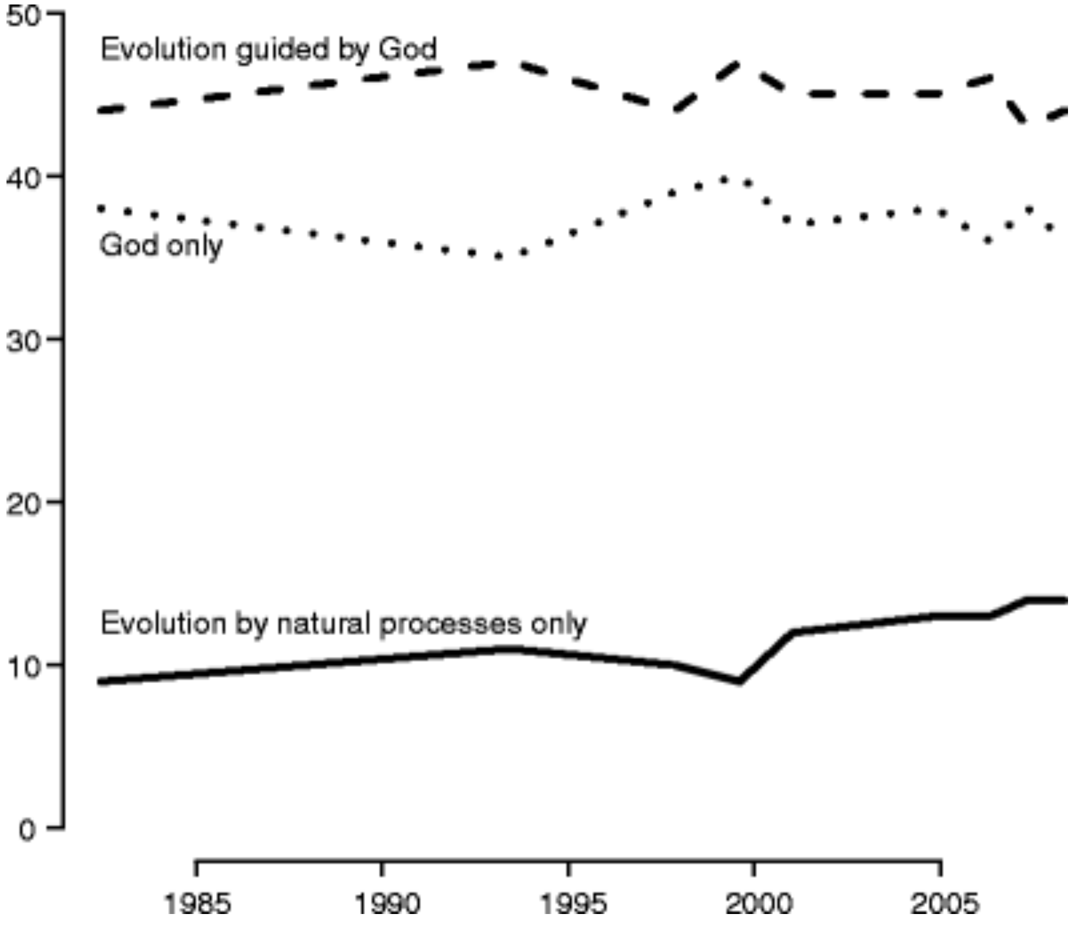

Figure 2. Responses from Gallup polls on evolution 1982-2007. Three strands of views when it comes to evolution; Theistic Evolution, ("Evolution guided by God"), Naturlistic Evolution, "Evolution by natural processes only," and Creationism ("God only"). Taken from Eve *et al*., 2010.

Few surveys have been conducted to estimate the Norwegian populous´ rate of C and ID. However, of the few surveys there are relatively few Norwegians align themselves with those beliefs compared to the US (Elgmork, 1994; Mysterud and Steen, 2000; Hessen *et al*., 2009; Anonymous, 2008; Kjetland *et al*., 2015). The US has a stable number of people who deny evolution altogether, or whom think that evolution happened but is guided by God (Fig. 2).

1.3 The Survey Instrument

1.3.1 Introduction

In addition to the 24 questions from the I-SEA survey instrument, I have added some questions of my own. These questions try to ascertain basic demographic and background variables of the respondents. The questions asked were the sex, age and region of the country where the respondents were from. As well as if they had taken an evolution course, and if any of their courses taught evolutionary theory, or if their syllabus/required readings mentioned it. Lastly, I also asked how many credits the respondents had taken in their respective field of study (Appendix 1).

1.3.2 A Brief Survey of Survey Instruments

There were several survey instruments to choose from depending on what the purpose of the survey was. Pobiner (2016) gives a fairly comprehensive review of some of the most recent ones. Those that seemed most relevant to my research goals were the MUM (Measure of Understanding Macroevolution), CINS (Conceptual Inventory of Natural Selection), MATE (Measure of Acceptance Toward Evolution) and the I-SEA (Inventory of Student Evolution Acceptance). To be sure there were other survey instruments with different emphasis, and different questions (e.g. Bishop and Anderson, 1990; Nehm and Reilly, 2007; Nadelson *et al*., 2014; Smith *et al*., 2016). The four selected surveys fall into two separate categories: surveys that aim to measure *understanding* of aspects of MET, and surveys that aim to measure *acceptance* of aspects of MET. The MUM and the CINS fall into the former category, while the MATE, and the I-SEA fall into the latter.

The MUM aims to test five major facets of modern evolutionary biology, namely deep time, phylogenetics, speciation, fossils and the nature of science (Nadelson and Southerland, 2010). The MUM therefore gives a broad, and comprehensive review of what undergraduate students at a university should learn when encountering evolutionary theory.

The CINS on the other hand, is much more narrow in scope and in the number of concepts it tests (Anderson *et al*., 2002). It tests for various aspects of natural selection, and common decent in three real-life based scenarios.

The MATE aims to measure acceptance of various parts of modern evolutionary theory by asking respondents of the survey to rank statements on a scale from A (strongly agree) through B (agree), C (undecided), D (disagree), to E (strongly disagree) (Routledge and Warden, 1999; Routledge and Sadler, 2007). And by obtaining these results hope to estimate what kind of underlying attitudes (i.e. construct) the respondents have, and possibly also to identify which surveys are of the C, or ID persuasion, or if the respondents have anti-science attitudes.

The 20-item MATE uses five subscales related to personal acceptance of evolution; acceptance of the scientific validity of evolutionary theory, biblical creationism, the evolution of humans, the acceptance of evolutionary theory among the scientific community, and the age of the earth (Nadelson and Southerland, 2012). The MATE has been widely employed to measure teachers´ and students' acceptance of evolution as it is found to be both internally consistent (Cronbach´s α= 0.94) with a strong test-re-test reliability (Pearson´s r =0.92) (Routledge and Sadler, 2007).

1.3.3 The Survey Instrument: The I-SEA

The I-SEA, which is a modification of the MATE was chosen for a number of reasons. First, the instrument had already been used by investigators before us **(**Chamberlain, 2015; Winter, 2016**).** Second, the instrument had already been tested with high school pupils and undergraduate students, and the final instrument has a high internal reliability of Cronbach´s α of 0.96, and the test items reflect documented evolution acceptance conditions (Nadelson and Southerland, 2012). Third, the questions fit well for measuring the research objectives. Fourth, the survey instrument had an entire subsection on human evolution, and for these purposes that was ideal to test if there were any differences between students of different disciplines.

In fact, the developers of the I-SEA themselves state: "The determination and interpretation of the levels of evolution acceptance of specific groups of students would be a fruitful direction for future research, and excellent application of the I-SEA." (Nadelson and Southerland, 2012: 1658).

The I-SEA do have a few advantages over the MATE: some questions in the MATE conflate acceptance of evolution with understanding of specific content (Smith, 2010), and the MATE does not explicitly account for the taker´s acceptance of the context of evolution in terms of differentiating between acceptance of micro-, macro- and human evolution (Nadelson and Southerland, 2012).

1.4 Scope of the Thesis

The overarching theme of this thesis, and the main question in focus is: are students in biology, medicine, and psychology accepting MET, and are there any differences between the disciplines in acceptance rates. One major effort to understand, and to make Darwin´s theory of evolution more prominent in classrooms and education, is to understanding how students perceive it, and what kind of attitudes they have toward it. Perceptions matter, they influence how people think, and how open they are when encountering a topic especially a controversial one. People also approach topics differently if they have been primed to be apprehensive about it from the beginning (Shermer, 1997; Shermer, 1999; Shermer, 2011). If a person perceives an idea as negative or associate the idea with a certain worldview, that person´s acceptance, knowledge, and understanding of that idea might be impacted (Brem *et al*., 2002; Hokayem and BouJaoude, 2008; Manwaring *et al*., 2015).

I will split my thesis into two major sections. The first major section, Chapter 1, aims to show my own research findings of undergraduate students in biology, medicine, and psychology at four public universities in Norway for acceptance of MET using the I-SEA survey instrument. The second major section, Chapter 2, consists of three subsections. One subsection on why students and staff at universities reject MET. One subsection on why MET should be integrated in the biology, medicine and psychology curriculum with an emphasis on EP. And one subsection on how to persuade students to accept MET.

1.5 Research Questions with Predictions

My basic research questions are:

(1) What are the overall acceptance rates of MET among undergraduate students across all disciplines and universities?
(2) What are the overall acceptance rates for human evolution; in particular, how many students have attitudes aligned with C or ID?
(3) To what extent are students in biology, medicine, and psychology being taught EB, EM and EP?
(4) Are there any statistical significant differences between those undergraduate students that studied biology, medicine, and psychology in acceptance of MET?
(5) Does student familiarity with evolutionary theory, gender, region or age make a difference in acceptance of MET?
(6) How large is the effect of the explanatory variables above?

Hypotheses for my basic research questions:

(1) Overall acceptance: The overall acceptance rates are expected to be high because of two reasons. First, Norway as a country—when surveying the

general populous—has consistently shown high rates (above 75%) of acceptance in previous studies (Mazur, 2005; Miller *et al.*, 2006; Coyne, 2012). Second, research has shown a strong positive correlation between a country's gross domestic product, school-life expectance (i.e. number of years a person of school entrance age can expect to spend within the specified level of education, UNESCO´s definition), and science literacy, and a negative correlation between a country´s religiosity, and acceptance of evolutionary theory (Heddy and Nadelson, 2012). Though few surveys exists to compare with students will likely have a significantly higher acceptance of evolutionary theory than the general populace due to the fact that researchers have found that there is a strong link between level of education and acceptance of evolutionary theory (People for the American Way Foundation, 2000; Brumfiel, 2005; Mino and Espinosa, 2009; Nadelson and Southerland, 2010).

(2) Acceptance of Human Evolution: For similar reasons outlined above I strongly suspect high acceptance rates of human evolution with very low levels of prevalence of ID or C among undergraduate students.

(3) Differences in teaching MET between disciplines: Biology students are most likely familiar with evolutionary theory because evolutionary theory has had a central place in biology for the past 150 years, and has also been commonly taught as part of biology students formal education. EP is a new discipline, and EM is arguably an even newer discipline (both started in the 1990s), thus lacking the tradition of including these fields in psychology and medicine students´ education. Surveys confirm EP as a subfield of psychology with few course offerings across the US at institutes of higher learning (Norcoss *et al.*, 2016). Similar results have come up for surveys on EM for medicine students (Nesse and Schiffman, 2003; Hidaka *et al.*, 2015). In addition, resistance in some subfields of psychology and medicine are still evident (Perry and Mace, 2010; Hidaka *et al.*, 2015).

(4) Differences between disciplines in overall acceptance of modern evolutionary theory: I predict that biology undergraduate students will have a higher rate of acceptance than either of the two other disciplines. Biology and medicine would have higher rates than psychology due to the fact that medicine is closer in its subject matter than psychology is, and that traditionally the social and

behavioral sciences have resisted biological explanations (Pinker, 2002; Cornwell *et al*., 2005; Kenrick, 2006; Perry and Mace, 2010).

(5) Explanatory variables: (a) Effect of evolution course, course in evolutionary biology/medicine/psychology, or mention of those disciplines in the required readings/syllabi: I do expect that haven taken a course in evolution have some influence on students acceptance of evolutionary theory (Mino and Espinosa, 2009; Nadelson and Southerland, 2010). (b) Effect of gender: I do not expect any significant differences between the sexes, as I do not see any arguments for why that should be the case, or have reviewed any literature where they have found any significant sex differences in acceptance of MET. If there are any sex differences I expect them to be small, and more reflective of men´s decisiveness than inherent differences in acceptance itself (Cunningham and Wescott, 2009; Rice *et al*., 2015) (c) Effect of region: I hoped that region could serve as a proxy for religiosity, as religiosity is among the most consistent, and largest factors influencing acceptance of evolutionary theory (Williams, 2009; Coyne, 2012; Heddy and Nadelson, 2012). Though not as strong as in the US, Norway has a "Bible Belt" generally associated with the region "Sørlandet." (d) Effect of age: There may be differences between the age groupings due to the fact that older students in biology with more coursework behind them have been shown to have higher acceptance rates of MET (Mino and Espinosa, 2009; Nadelson and Southerland, 2010).

(6) Effect size of the explanatory variables: I expect the size of all of my proposed explanatory variables to fall within the small effect size range due to the fact that any given explanatory variable is going to have a small effect on an already highly accepting population of individuals (i.e. students at a public university) in an already highly accepting western, industrialized country (i.e. Norway), leaving very little room for "improvement" on top of that. Hemphill (2003) reviewed 380 meta-analytic studies showing that approximately one-third of the correlation coefficients are less than 0.20, one-third fall between 0.20 and 0.30, and one-third are more than 0.30 in magnitude. He further remarks that Cohen´s original benchmark for large effect sizes occur infrequently in social science.

2. Materials and Methods

2.1 Study Sites

In Norway there are only eight public universities stretching the length of the country from the South to the North. I choose four of those eight universities because these were the only ones that had program offerings in all three disciplines: biology, medicine and psychology.

The public universities in Norway arranged from southernmost to northernmost goes as follows: UiO, UiB, NTNU and UiT. All of the universities are associated with a region of the country and a prominent city (Appendix 2).

The I-SEA aims to measure the respondents' acceptance of three major aspects of evolution: Macroevolution, Microevolution and Human Evolution (Nadelson and Southerland, 2012). The scale goes from five (strongly agree) through four (agree), three (undecided), two (disagree), to one (strongly disagree). It is important to note that quite a few of the items had a reversed scale (items two, six, nine, 12, 13, 15, 19 and 22). Traditionally in the social sciences researchers have thought that by including revere-scale items in surveys biased results due to wording of the statements posed are avoided (Couch and Keniston, 1960). However, newer models have suggested that reverse scaling items in surveys is not without problems of their own, namely acquiescence, careless responding and confirmation bias (Weijters *et al*., 2013).

The I-SEA has three subsections consisting of eight statements each (Appendix 3). The first section, on Macroevolution, aims to measure acceptance of evolution taken place over long periods of time including the formation of new species. One example of such a statement is "I think that new species evolved from ancestral species" (item 1). The second section, on Microevolution, aims to measure acceptance of evolution over small periods of time within a single species. An example of such a statement is "I don´t accept the idea that a species of organism will evolve new traits over time" (item 13). The third section, Human Evolution, aims to measure acceptance of how humans have evolved over time from primate ancestors. One example of such a statement is “I think that humans and apes share an ancient ancestor” (item 20).

2.2 Sampling Procedure

The target population was undergraduate students that go to a public university where all three majors are taught. The unit of analysis was students. The goal was to try and get as many participants as possible for my sample so as to be as representative of the population as possible.

I wanted to include only undergraduates so I attempted to exclude sending out mass-emails to those students, and with every advertisement announcement of the survey I made it clear that only undergraduate students were eligible to be included in the survey. I stated this when corresponding with all my collaborators as well.

Several strategies were utilized to distribute the survey to the target population and to obtain a representative, randomized non-biased sample. First, I contacted lecturers in undergraduate courses, and asked them if they would either give me the mailing list of their students, if they would inform the students of the survey in their class, if they would post a note on their class website, and if they would send out a mass-email and reminders to their students.

Second, contacted different student organizations to help promote the survey on social media, specifically on their official Facebook page, at their meetings, and to send out mass-emails to their members.

Thirdly, I corresponded with student advisors at all the universities, and asked them to either give me the mailing list, or to send out mass-emails of their own with reminders.

Fourthly, I traveled to two universities, UiO and NTNU, to hang up posters, talk with student organizations to help promote the survey, and to talk to some professors that could help me (Appendix 4).

The amount of time set to accept surveys was about two months. The project was set to end on 10th of June 2014. The project was applied for approval with the Norwegian Social Science Data Services with project number 37830 (Appendix 5 and 6).

2.3 Data Analysis

Pearson´s *chi*-square tests of independence (χ^2) were performed to test the independence of two categorical variables and an explanatory variable. The chi-square test is suitable for unpaired data from large samples, and data sets that pass these two assumptions: (1) The two variables compared should be measured at an ordinal or nominal level. (2) The two variables should consist of two, or more independent groups.

Cronbach´s α or the *tau*-equivalent reliability is used as an estimate of the reliability of a psychometric test. Cronbach´s α is proximately the expected correlation of two tests that measure the same construct. Cronbach´s alpha is a function of the number of items in a test, the average number of covariance between item-pairs, and the variance of the total score. The scale of reliability goes from 0—1, where above 0.9 is excellent, between 0.9 and 0.8, is good, 0.8 and 0.7 is acceptable, 0.7, and 0.6 is questionable, and 0.6 and 0.5 is poor, and below 0.5 is unacceptable (Cortina, 1993).

Levene´s test is an inferential statistic used to assess the equality of variances for a variable calculated for two or more groups. The test assesses the assumption that variances of the populations from which different samples are drawn are equal. Two of the tests which Levene´s statistic is used for are *t*-tests and analysis of variance (ANOVA) because both have the assumption that variances must be equal.

The *t*-test (a simpler version of an ANOVA) assesses whether the means of two groups are statistically different from each other. The assumptions of a *t*-test are as follows: (1) the data has a normal distribution, (2) the two groups being compared are independent of each other and (3) homogeneity of variances.

ANOVAs are a collection of statistical models used to analyze the differences between and among group means and among their associated procedures. The one-way ANOVA provides a statistical test for if there are statistically significant differences between means of groups. ANOVA is useful for testing or comparing three or more means for statistical significance. The ANOVAs share the same three assumptions as the *t*-tests.

If the data violates the assumption of equality of variances, Welch´s *t*-test, or Welch´s ANOVA was used instead. Welch´s *t*-test or ANOVAs test the hypothesis that populations have equal means, but do not assume equality of variances. Assumptions of this test are: (1) that the two populations have normal distribution, (2) that no temporal trends exist in the data, (3) no spatial variability is present, and (4) the samples are statistically independent.

However, the ANOVA cannot tell you which specific groups were significantly different from one another. To be able to tell which specific groups were different, *post hoc* tests are utilized.

Tukey´s range test is a *post hoc* statistical test, and is also a single-step comparison procedure. The test compares all possible pairs of means, and is based on a studentized range distribution. Tukey´s test compares the means of every treatment to the means of every other treatment, meaning it applies at the same time to all pairwise comparisons, and identities any difference between two means that is greater than the expected standard error. The assumptions of the Tukey test are: (1) the observations being tested are independent within and among the groups, (2) the groups associated with each mean in the test are normally distributed, and (3) there is equal within group variance across the groups associated with each mean in the test.

Games-Howell *post hoc* test is a non-parametric approach to compare combinations of groups or treatments. The Games-Howell test does not assume equal variances and sample sizes.

Effect size measure either the size of association or the size of differences. Cohen´s *d* is one way to measure the effect size of differences in means between two group means and is thus used after *t*-tests. Cohen´s *d* is simply the difference in two groups means divided by the average of their standard deviations. Cohen provided a rule of thumb for interpreting effect sizes: d=0.2 is a small effect size, 0.5 represents a medium effect size, and 0.8 a large effect size (Cohen, 1988).

The total number of surveys was 591. I examined all the filled-in surveys, and eliminated those that conveyed a lack of thoughtful participation, such as those that skipped over half of the questions. My remaining set contained the completed surveys of 583 participants (meaning 1.43% eliminated from the analysis). Of the surveys included in the data analysis, very few revealed to have a missing response for an item. I completed the conditioning of the data by reverse coding the response to the items of the I-SEA that were negatively phrased (reversed).

All statistics were done in SPSS v. 23 or in Excel 2011.

3. Results

3.1 Profile of Respondents

The overall response rate was 11%[1]. Biology majors´ response rate was 32%; medicine majors´ was 13%, and psychology majors was 5%. The response rates for the universities were: 17% for UiB, 9% for UiO, 11% for UiT and 19% for NTNU.

Table 2. Number of participants in the study broken down by major and university.

Major / University	Biology	Medicine	Psychology	Total
NTNU[1]	30	111	16	157
UiB[2]	37	134	7	178
UiO[3]	89	2	61	152
UiT[4]	39	27	30	96
Total	195	274	114	583

[1] = Norwegian University for Science and Technology, [2] = University of Bergen, [3] UiO = University of Oslo, [4] = University of Tromsø

The total number of participants across all disciplines and universities was 583, unevenly distributed between disciplines and universities. In particular, the participants from psychology at UiB was only seven, and for medicine at UiO only two (Table 2). For more information about the demographics of the respondents see (Appendix 7).

[1] All response rates were obtained by contacting the student administration at each university, except at two departments: UiB (Psychology) and NTNU (Medicine). For those two numbers I had to consult an online database (”NSD-Database for Statestikk om Høgre Utdanning”) that keep records of how many students each program has for each university. The problem, however, is that these numbers deflate the response

3. 2 Overall Acceptance Rates of Modern Evolutionary Theory

Table 3. Mean acceptance rates, number of participants, and standard deviation for each of the three majors broken down by subsection of the I-SEA survey instrument.

Major	Subsection	Macroevolution	Microevolution	Human Evolution
Biology	Mean[1]	4,52	4,64	4,62
	Number of participants	195	194	195
	Standard deviation	0,56	0,37	0,50
Medicine	Mean[1]	4,38	4,53	4,43
	Number of participants	273	273	273
	Standard deviation	0,80	0,50	0,82
Psychology	Mean[1]	4,29	4,48	4,48
	Number of participants	114	114	114
	Standard deviation	0,72	0,43	0,66
Total	Mean[1]	4,41	4,55	4,50
	Number of participants	582	581	582
	Standard deviation	0,71	0,45	0,70

[1] The scale for the survey instrument goes from 5=strongly agree, 4=agree, 3=neither agree nor disagree, 2=disagree, to 1=strongly disagree.

The mean overall acceptance rate of all undergraduate students in my sample was 4.49 (SD=0.62) with similar albeit different rates for each discipline in each subsection (Table 3).

Table 4. Select statements from the I-SEA survey instrument of particular interest that signal either acceptance of modern evolutionary theory (1 and 4) or disbelief in Intelligent Design (ID) (3) and Creationism (2) among undergraduate student participants.

Subsection	Statement / Scale	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree

1 Macroevolution	I think new species evolved from ancestral species.	9 (1,5%)	10 (1,7%)	12 (2,0%)	97 (16,5%)	460 (78,2%)
2 Microevolution	Species were created to be perfectly suited to their environment, so they do not change (reverse).	430 (73,4%)	131 (22,4%)	21 (3,6%)	3 (0,5%)	1 (0,2%)
3 Human Evolution	I think that the physical structures of humans are too complex to have evolved (reverse).	439 (74,9%)	94 (16,0%)	23 (3,9%)	14 (2,4%)	16 (2,7%)
4 Human Evolution	I think that humans and apes share an ancient ancestor.	15 (2,6%)	12 (2,0%)	30 (5,1%)	137 (23,4%)	392 (66,9%)

Select questions from all three subsections of particular interest were pooled together across all universities and disciplines. These statements were designed to measure attitudes that signal C or ID beliefs. Overall, very few participants harbor these beliefs (Table 4).

3.3 The State of Evolution Education in Norwegian Public Universities

Table 5. Undergraduate student participant response to the question "Have you taken a university-level course in evolution before?"

	Response: "My general biology course had a module on evolution."			
	Overall	Biology	Medicine	Psychology
Yes	179 (30,4%)	107 (54,9%)	50 (18,2%)	22 (19,3%)
No	409 (69,6%)	88 (45,1%)	224 (81,8%)	92 (80,7%)
	Response: "I have had a course in evolution and ecology."			
	Overall	Biology	Medicine	Psychology
Yes	108 (19,4%)	89 (45,6%)	16 (5,8%)	2 (1,8%)
No	480 (81,6%)	106 (54,4%)	258 (94,2%)	112 (98,2%)
	Response: "I have had a course in evolution."			
	Overall	Biology	Medicine	Psychology
Yes	65 (11,1%)	39 (20,0%)	15 (5,5%)	10 (8,8%)
No	523 (88,9%)	156 (80,0%)	259 (94,5%)	104 (91,2%)

Overall, only 11% of participants reported to "have had a course in evolution." For every statement, biology students report to have more experience with evolution than either medicine or psychology (Table 5).

Table 6. Undergraduate student response to if they have had evolutionary biology mentioned in any of their courses in biology, evolutionary medicine mentioned in any of their courses in medicine, and evolutionary psychology mentioned in any of their courses in psychology.

Major	Response		
	Yes	No	Don´t know
Biology	173 (89,6%)	110 (40,3%)	105 (92,1%)
Medicine	11 (5,7%)	87 (31,9%)	3 (2,6%)
Psychology	9 (4,7%)	76 (27,8%)	6 (5,3%)

Over 90% of psychology and biology majors report that a course in their field taught EP or EB, respectively (Table 6).

Table 7. Undergraduate student response if they have taken a course in biology where evolutionary biology was taught (for biology majors), in medicine where evolutionary medicine was taught (for medicine majors), or in psychology where evolutionary psychology was taught (for psychology majors).

Major	Response		
	Yes	No	Don´t know
Biology	178 (91,3%)	13 (6,7%)	4 (2,1%)
Medicine	169 (62,4%)	70 (25,8%)	32 (11,8%)
Psychology	111 (97,4%)	1 (0,9%)	2 (1,8%)

More psychology majors reported having EP mentioned in their syllabus/required readings than biology students reported mentions of EB in their syllabus/required readings. Less than half of medicine majors reported mentions of EM (Table 7).

3.4 Differences Between Disciplines in Acceptance of Modern Evolutionary Theory

The Cronbach´s α for the macroevolution subsection is 0.92, for microevolution 0.77 and for human evolution section 0.94. The overall average was 0.88. Overall, this shows high internal consistency for each item measuring the same construct.

The Levene´s statistic to test for homogeneity of variances for macroevolution was 7.31 (p=0.001), for microevolution 5.09 (p=0.006), and for human evolution it was 13.83 (p<0.001).

A Games-Howell *post hoc* test revealed that biology majors had statistically significant higher acceptance rates when compared to psychology for macroevolution. Biology majors had higher acceptance rates compared to medicine and psychology for microevolution. Biology majors also had higher acceptance rates than medicine for human evolution (Appendix 8).

3.5 Influence of External Factors on Acceptance of Modern Evolutionary Theory

Haven taken an evolution course did make students more likely to accept Macro- and Human Evolution. Females agreed less with the statements in the Microevolution subsection than the males. There was a small statistically significant effect of taking a course in EB, but only for the Microevolution subsection. Haven taken EM or EP made no difference for those asked. Having mentioned evolutionary theory (EB, EM or EP) did not have any influence on student acceptance rates. The mean acceptance of MET from undergraduate students from “Sørlandet” was statistically significant lower than any of the other regions. However, only nine participants reported to be from “Sørlandet” in total, so this sample is not representative of students from the whole region. The 18-22 year old group had lower acceptance rates compared to 23-26 year old group for microevolution (Appendix 9).

The effect sizes for all statistically significant explanatory variables fall in the small range (Appendix 10).

4. Discussion

4.1 Validity of the Survey

This type of educational research usually uses something called stratified random sampling to ensure that specific subgroups of people are adequately represented within the sample. The procedure for this stratified random sampling is:

- Determination of the strata that the population will be divided into.
- Determination of the number of participants necessary for each stratum (to ensure that the characteristics of the sample is similar to the characteristics of the population).
- Splitting the units of analysis into respective strata.
- Randomly sample participants from within the groups using a random number table.

Unfortunately, this procedure for sampling the undergraduate population at different universities was not upheld systematically. As a result, there were at least two major concerns when it came to the sampling procedure: first, if the sample was representative. Unfortunately, due to low response rates, it is very difficult to argue that the sample is completely representative of the population. I think more effort was put into getting responses from biology majors than the two other groups. To me it also seemed like people associated with the biology programs were more willing to help than people in either medicine or psychology. And finally, that more people in biology advertised the survey on social media, and sent out mass-emails to their students.

Second, if there were any biases, specifically if the respondents of the survey was chosen in a way that makes some individuals less likely to be included in the sample than others. The efforts of getting undergraduate students at the four different universities to take the survey, can broadly be divided into two groups: (1) lecturers giving out the survey in class, and mass-emails, and other efforts where lists of students are used to send out the survey, and (2) posters that were hung up in and around the campus at some of the universities. Due to the fact that I did not collect any data for how the participants came across the survey, reliable estimates for how many students are in each of these groups is impossible to ascertain. In the latter effort, I suspect a large bias because only people looking at notice boards, and who were interested would take the survey (i.e. self selection bias) (Bethlehem, 2010; Greenacre, 2016). The overall response rate I got is not that uncommon for this type of online survey (Porter and Whitcomb, 2003) (Appendix 11).

4.2 Overall Acceptance of Modern Evolutionary Theory

As predicted the overall acceptance rates among the undergraduate students were 4.49 (SD=0.62). This is really high considering the scale goes from one to five where five is most in agreement with MET. These results are expected because Norway has high acceptance rates among the general populace. Mazur (2005) found that Norway´s rejection rate of the proposition that humans have evolved from earlier species was only 23%, with similar results in neighboring countries: Sweden, 17%, and Denmark, 11%. Miller *et al*., (2006) found that about 70% of the general population accepted evolution as a true concept, with even higher acceptance rates in our neighboring countries: Sweden with about 80%, and Denmark with a little over 80%.

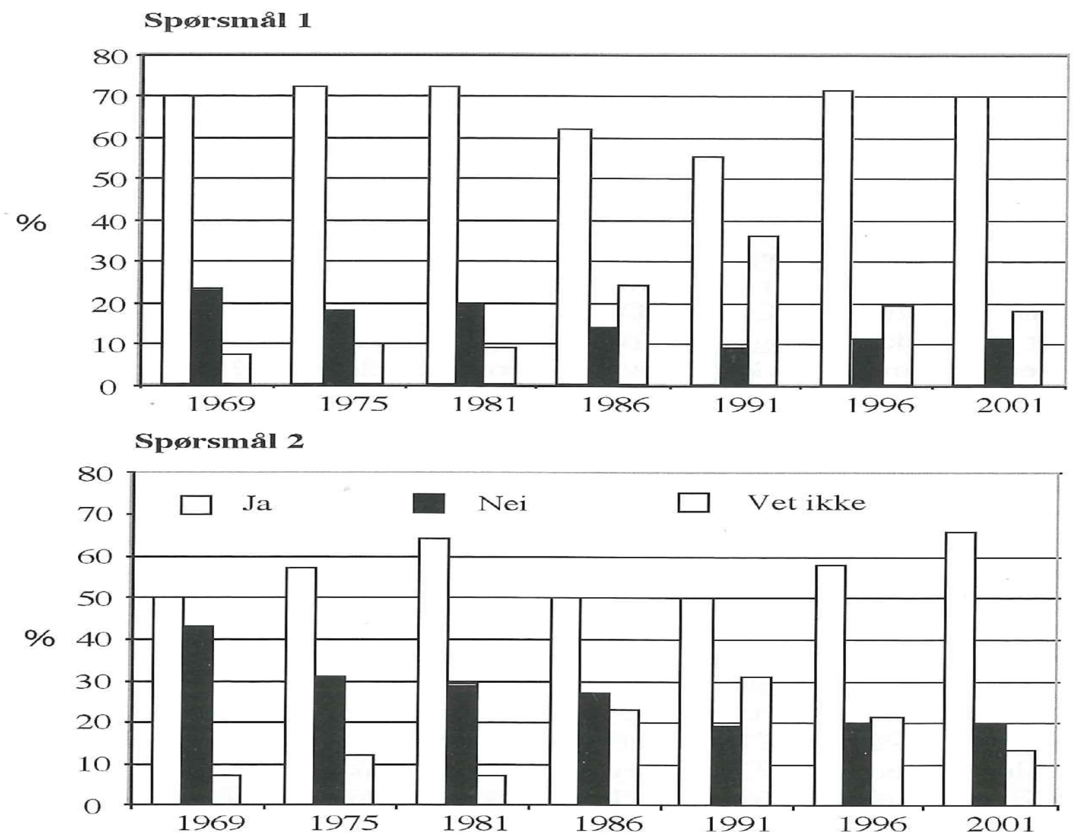

Figure 3. Two annual questions asked from 1969-2001 of undergraduate students in biology at the University of Oslo. Question 1: "Do you believe that there has been an evolution in the animal kingdom, generally from lower to higher kinds through long stretches of time?" Question 2: "Do you think humans are in the same chain in this evolution, and that apes and humans through long stretches of time evolved from a common ancestor that now is extinct?" Ja = Yes. Nei = No. Vet ikke = Do not know. Spørsmål 1= Question 1. Spørsmål 2 = Question 2. Taken from Hessen *et al.*, 2009.

While national surveys for both the general populace, and for students and staff at universities are scarce, a few surveys do exist. Elgmork (1994) prompted a polling agency to ask the following two questions every year from 1969 to 2001: (1) "Do you believe that there has been an evolution in the animal kingdom, generally from lower to higher kinds through long stretches of time", and (2) "Do you think humans are in the same chain in this evolution, and that apes and humans through long stretches of time evolved from a common ancestor that now is extinct?" (Both questions translated by the author from the original Norwegian) (Fig. 3). There are at least two points to note about the graphs: the first is that the number of "No´s" and "Don´t knows” at some points make up about half the answers. The second point is that more people are willing to accept the evolutionary process, as long as humans are kept out if it (Hessen *et al*., 2009). Mysterud and Steen (2000) used the same two questions as Elgmork in an annual survey of 192 students at Diaconia College Centre in Oslo during the years 1996 to 1999. The majority of students answered “yes” to the first question over all the years. On the second question, however, the majority said “no.” A national survey commissioned by the NRK, and conducted by Norstat (2008) revealed that only 59% of Norwegians strongly agree that humans are part of the evolutionary process, and 12% disagreed or strongly disagreed.

Kjetland *et al*. (2015) surveyed primary school pupils over the question “Have humans been on Earth always?” They found that the pupils lacked any systematic knowledge in this field, and that they simply just make up their own explanations. The authors argue that teachers in middle school have the burden of not only teaching evolution, but also to correct misconceptions, making it very hard to teach in a manner that the material deserve.

The results of my survey show that 94% said they either agreed or strongly agreed with the statement “I think new species evolved from ancestral species”, and 90% agreed or strongly agreed with the statement “I think that humans and apes share an ancestor.” One major reason for the much higher acceptance rates in our sample is that our participants consisted of university students. Educational attainment has been shown to correlate with higher rates of MET acceptance (People for the American Way Foundation, 2000; Brumfiel, 2005; Minõ and Espinosa, 2009; Nadelson and Southerland, 2010). And Norway has higher much higher acceptance rates than many other countries including the US (Miller *et al*., 2006; Coyne, 2012).

4. 3 Teaching Modern Evolutionary Theory in the Classroom

4.3.1 Evolutionary Biology in Biology

The undergraduate students in my sample that claimed to have taken a course in evolution were only 11%, where the majority of those were biology majors. However, a significantly higher percentage of the sample (30%) said that their general biology course had a module on evolution[2]. Of those who answered yes, most were biology majors. 91% claimed that a biology course taught EB. 90% claimed that EB was mentioned in the syllabus/required readings.

4.3.2 Evolutionary Psychology in Psychology

Of the students in our survey, 97% of psychology majors reported that a course they had taken taught EP, while 92% claimed that EP was mentioned in the syllabus/required readings. This was a surprising finding, and the opposite of what I predicted. The reasons might be that despite that EP is a new and budding discipline within psychology a lot of textbooks includes a chapter on biology. In that chapter EP is probably mentioned, but the treatment of this field is likely to be superficial and narrow.

Norcoss *et al*. (2016) found through their survey that 38% of Baccalaureate Programs for psychology majors in the US in 2014 offered a course in comparative psychology/animal behavior, 66% of programs offered a course in cross-cultural psychology, and only 29% of programs offered a course in EP. The number of offerings for a course in EP was 0% in 2005 and 1996. When an EP course was offered only 1% of programs have EP as a required course.

An examination of introductory psychology textbooks over the past 30 years by Cornwell *et al*. (2005) found that a Darwinian perspective has gained acceptance and

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[2] Presumably only undergraduate students who have taken a general biology course answered this question. I did not analyze the data to see what the breakdown of the disciplines were for this question of the survey, because it would require a very roundabout way of determining which discipline each respondent of this question belonged to.

influence within the field of psychology. However, they also found that EP is often perceived as narrowly defined, limited to research on mating strategies, and that the material on biology was often confined to only one chapter where the authors of the textbook often emphasized the importance of the environment.

Fergusen *et al*. (2016) surveyed 24 leading introductory psychology textbooks for their coverage of controversial topics, and scientific urban legends for their factual accuracy. One of those issues was evolution and mating choices. The authors suggest that it remains possible that psychology textbooks may shy away from discussing evolutionary influences in favor of standard socialization models of such behaviors. In their survey that found that 21% of textbooks did not cover the topic of evolution/mating, and 25% were biased and 37% were partially biased against an evolutionary perspective.

4.3.3 Evolutionary Medicine in Medicine

Only 62% of medicine majors reported that a course they have taken taught EM. Less than half (40%) claimed that EM was mentioned in the syllabus/required readings.

Hidaka *et al*. (2015) evaluated the status of EM in North American medical schools. Compared to the 2003 survey (Nesse and Schiffman, 2003), a range of evolutionary principles was covered by 4% to 74% more schools. Almost half (48%) of responders anticipated starting controversy at their medical school if they added MET to their curriculum. Furthermore, limited resources (faculty expertise) were cited as the major barrier to adding more evolution. The authors suggest that efforts to improve evolution education in medical schools should be directed toward boosting faculty expertise, and crafting resources that can be easily integrated into existing curricula. 40% of schools valued an undergraduate course in EB for admission, but a course in evolution was not required by any school, and was recommended by only 2 (4%). Compared to the 2003 survey, the number of evolutionary biologists on the faculty has increased by 27%, so has devoting any curriculum hours to teaching evolution by 17%, and reported coverage of all the topics ranging from 4% to 74%.

4.4 Differences Between Disciplines in Acceptance of Modern Evolutionary Theory

The results from my survey show that biology majors had higher acceptance of evolution than psychology for Macroevolution and Microevolution. In addition, biology majors had higher acceptance rates than medicine for Micro- and Human Evolution. However, all the differences were small (as indicated by Cohen´s *d*).

Minõ and Espinosa (2009) conducted a study where they looked at a secular and a religious college, and differences between them for biology majors and non-majors. The biology majors regardless of their college affiliation were significantly more likely to support the exclusive teaching of evolution in science classes (as opposed to include the teaching of C or ID), to not perceive ID as an alternative scientific theory to evolution, to prefer science courses where human evolution is discussed, and to accept evolution openly or privately.

Rice *et al*. (2015) set out to test if there were any statistical significant difference between different academic disciplines on measures of acceptance (using the Measure of Acceptance Toward Evolution) and understanding (using the Knowledge of Evolution Exam). They surveyed faculty from life sciences, social sciences, physical sciences, engineering, business, humanities and veterinary medicine. Highest acceptance of biological evolution was found within the social science faculty, while the highest knowledge of biological evolution were found in life science. Interestingly, the two disciplines with the largest mismatch between knowledge and acceptance were precisely those two disciplines life science and social science (Appendix 12).

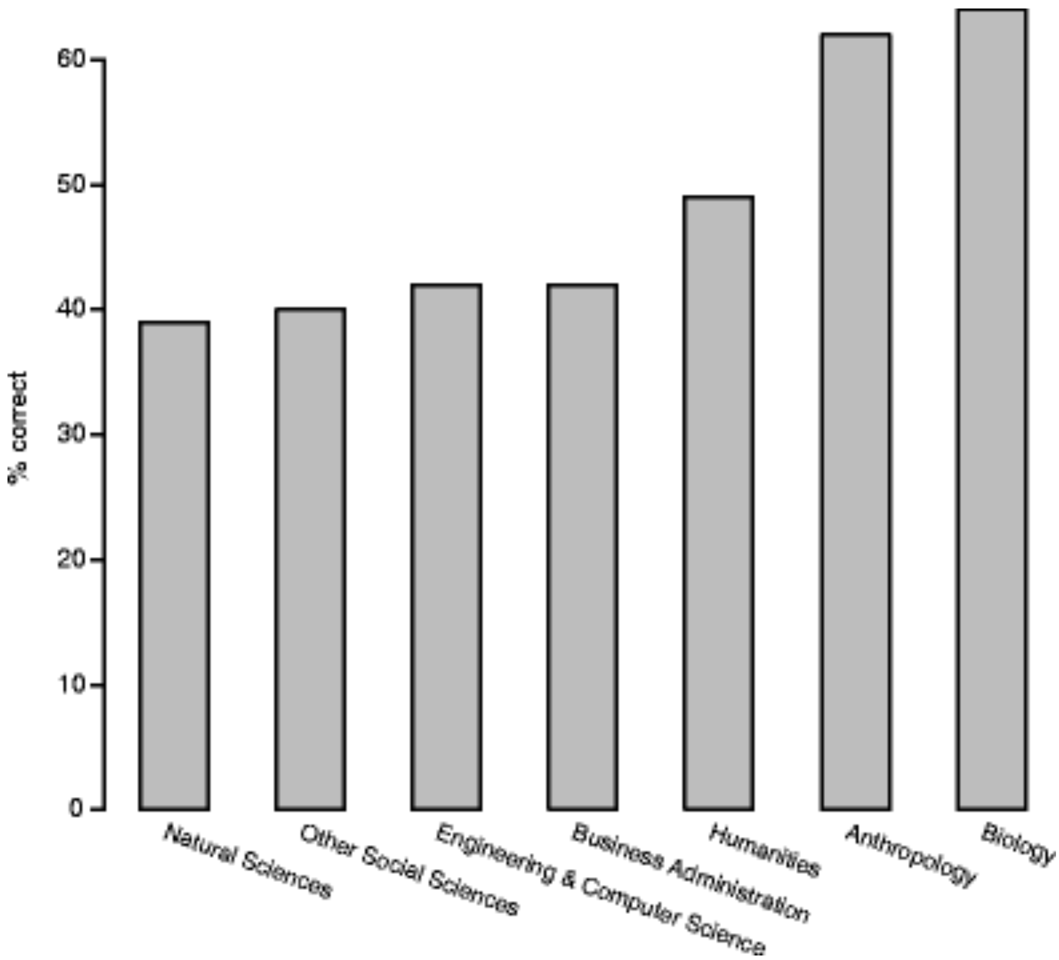

Figure 4. Percentage of students agreeing that "Human beings as we know them today developed from earlier species of animals," by major. Taken from Eve *et a*l., 2010.

Unpublished data reported in Eve *et al*. (2010) show that there are clearly differences in acceptance of human evolution among branches of academia, where biology and anthropology has the highest rates of acceptance, and natural sciences (biology excluded), and "Other social sciences" the lowest (Fig. 4).

4.5 Why Students and Staff at Universities Reject Modern Evolutionary Theory

The results of my survey show that there was a small difference in acceptance for Macro- and Human Evolution between those who took an evolution course, and those who did not.

These results are mirrored by Minõ and Espinosa (2009) who found that overall acceptance of evolution among biology students whether in a secular or religious institution of higher learning, increased gradually from the freshman to the senior year due to exposure to upper-division courses with evolutionary content. In light of this finding, it might not be coincidental that the age bracket 23-26 had higher acceptance rates for one subsection than 18-22 year olds (because they likely had more relevant coursework behind them). In addition, I found a small effect of having taken a course in EB for acceptance of Microevolution for biology majors.

Nadelson and Southerland´s (2010) analysis revealed that acceptance and understanding of macroevolution was correlated to the number of biology courses (r (741)=0.27; p<0.01). They also found that students´ understanding of Macroevolution and acceptance of evolution after the one-semester EB course increased. A study by Moore *et al*. (2009) show that high school biology courses are associated positively with students´ knowledge of evolution. However, there have been conflicting research in the literature, and some studies have found that taking an EB course has little or not affect on students views about evolution (Moore and Cotner, 2009; Moore *et al*., 2011).

Several studies have found that level of school-life expectancy (formal educational attainment) is positively correlated with acceptance of evolution (People for the American Way Foundation, 2000; Brumfiel, 2005; Heddy and Nadelson, 2012).

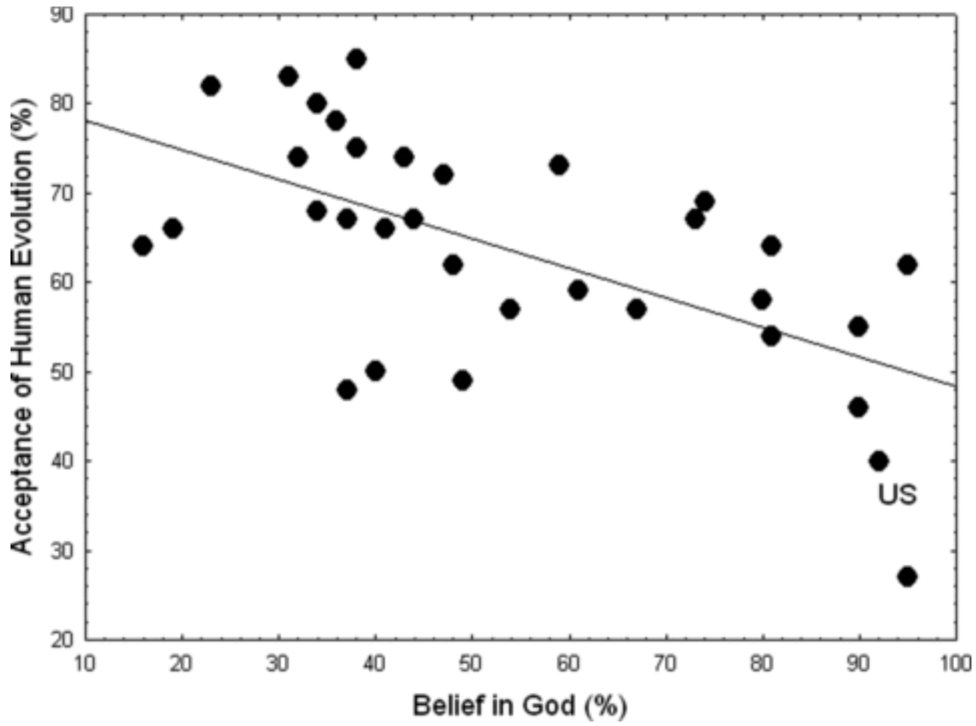

Figure 5. The correlation between belief in God and acceptance of human evolution among 34 countries. Acceptance of evolution is based on the survey of Miller et al. (2006). "Belief in God" comes from the Eurobarometer survey of 2005, except for data for Japan (from Zucerman, 2007), and for the United States (Gallup, 2011). US is the point for the United States. The correlation is -0,608 (p=0,0001), the equation of the least squred regression line is Y=81,47-0,33x. Taken from Coyne, 2012.

I found that people from Sørlandet, generally considered the Bible Belt, had lower acceptance scores than any other region of the country. The effect was small, however, as indicated by Cohen´s *d*, and the number of people who took the survey from this region was very few (*n*=9) and is thus not representative. Coyne (2012) argues that societies with low levels of religiosity are more successful than societies with high levels, and that acceptance of evolution is inversely correlated with belief in God, at the national level (Fig. 5).

A review by Thagard and Findlay (2009) suggests several different factors for why students do not accept MET: (1) Cognitive obstacles including conceptual difficulties such as adopting population thinking, rejecting teleological explanations, and grasping deep geological time. (2) Methodological obstacles include students' confusion regarding the many contradictory accounts of what would be involved in accepting Darwin´s theory. (3) Coherence obstacles because students fail to see evolution as a coherent explanation for the diversity of life, as well as perceived incoherence between common psychological views and Darwin´s theory. (4) Emotional obstacles arise because students often base their beliefs not solely on the basis of evidence, but on their goals, as well as the fact that evolutionary theory conflicts with some students' deepest held personal beliefs such as the existence of the soul, free will, conservative politics and religious fundamentalism.

Heddy and Nadelson (2012) explored the relationship on an international scale (instead of the usual individualistic scale that most researchers do) using secondary data to research evolution acceptance for 35 countries. Their results indicate significant relationships between public acceptance of evolution, and the following factors: religiosity, school-life expectancy (i.e. the average number of years of education a citizen has), science literacy, and gross domestic product (GDP) per capita. Though the four indicator variables overlap, the two largest coefficients were religiosity (negative correlation, r=-0.81, p<0.005), and school-life expectancy (positive correlation, r=0.76, p <0.005).

4.6 Conclusion and Suggestions for Future Research

My research confirms the existing literature that Norway has high acceptance levels of MET. Even compared to the general populace the undergraduate students sampled has high level of acceptance. I did found a small effect on acceptance of taking a course in EB, but the effect was small like the rest of the explanatory variables. A surprising number of students in psychology are familiar with EP, which is encouraging. However, the content of the treatment of EP is beyond these data, but reports from the US shows cause for apprehension; much of the teaching material contains errors in their treatment of EP, and often gives the impression that EP is a very narrow field of study.

My proxy for religiosity in this study though possibly reliable, failed to give an answer to the question of if student acceptance is negatively correlated with religiosity due to the fact that the number of participants in key regions of the country was small. Other factors that have been found to correlate with acceptance of MET are: GDP, science literacy, conservatism, psychological beliefs such as free will and the existence of the soul. Apart from the challenge of science educators to deal with the science and religion battleground, in the context of teaching evolution, research shows that a lot of people (including secular students) associate many negative consequences of accepting MET like selfishness and self-determination.

The literature on perceptions and attitudes towards MET in the Nordic countries is scarce with most of this literature focused on a national level, and not on an individual one. So many avenues of potential interest, and of potential pedagogical value are left unexplored. Science educators are likely to benefit from knowing how their students perceive of the material they are teaching and to know which obstacles face them as science teachers. Why faculty in disciplines beyond biology does not accept MET may also have significant value.

I make five concrete suggestions for future research possibilities to narrow the gap in knowledge: first, survey the staff in multiple disciplines (including biology) at several public universities to find out what they know (understand) about MET (for example by using the CINS or the KEE), and what they think about it (accept) (for example by using the MATE or the I-SEA). Second, survey students or staff at several universities in Norway about how they perceive MET (tool used in Brem *et al*. 2002?). Third, survey the general populace in Norway or the other Nordic countries using an instrument that measure acceptance, and corroborate these measures with suggested factors influencing acceptance from the literature to find out if these factors operate here too. Fourth, survey both public and private high school students in Norway and compare the two for measures on acceptance, understanding, and perceived impact of MET. Fifth, use two radically different approaches to teaching MET to high school pupils or university students, and compare the two groups on measures of acceptance, understanding and perception.

Chapter 2

Chapter 2 consists of three interrelated parts that puts a spotlight on some of the aspects discussed in Chapter 1. The first section argues for why MET should be included in the biology, medicine and psychology curriculum. The second section is a brief literature review about some of the findings evolution researchers have found about why students and staff reject MET at university and college. The third, and last section argues briefly why teaching MET is important, and some tips and guidelines for how to teach it effectively, especially with combating creationism and ID in mind.

5. Why Modern Evolutionary Theory Should Be Part of Biology, Medicine and Psychology

5.1 Evolutionary Biology in Biology

Evolutionary theory is fundamental to understanding the biological sciences and is the cornerstone to understanding almost every biological phenomenon (Dobzhansky, 1973; Dawkins 2010; Coyne, 2010). Evolutionary theory is frequently viewed as fundamental to science literary, which is also made evident by the inclusion of evolution in science education learning standards (Pigliucci and Kaplan, 2006).

Most academics in the scientific community accept the theory of evolution, despite current and heated debate over certain aspects of it, and of certain applications to humans. Most students in biology learn about evolutionary theory during their time at university. However, the situation seems not to be the same for students in medicine and psychology programs.

5.2 Evolutionary Psychology in Psychology

5.2.1 What Evolutionary Psychology Is

Evolutionary Psychology is a general approach to psychology that uses principles from evolutionary biology to shed light on psychological phenomenon (Buss, 2012; Gaulin and McBurney, 2004).

Evolutionary psychologists work by posing hypothesis about a psychological phenomenon, and making predictions on the basis of general modern evolutionary theory, and test if these predictions hold empirically. The range of phenomenon that evolutionary psychologists study and try to explain is vast and wide ranging; music (Pinker, 1997), literature (Gottschall, 2013), language (Pinker, 1994), consumer behavior (Saad, 2011), mating and sex (Buss, 2000; Miller, 2000;Miller, 2009; Buss, 2016), social norms and rules (Kenrick, 2011), religion (Boyer, 200x;Atran, 200x; Bellah, 201x), cognition (Shettleworth, 2009), arts (Dutton, 2010), morality (Hauser, 2006; Haidt, 2012; Boehm, 2012; Greene, 2013), aesthetics (Ramachandran, 1998; Ramachandran, 2011), violence (Pinker, 2011; Raine, 2013; Daly, 2016), mental disorders (Nesse and Williams, 1994; McGuire and Troisi, 1998) and sex differences between males and females (Baron-Cohen, 2003; Pinker, 2008).

5.2.2 How to Teach Evolutionary Psychology

In an interview, the pioneering and leading evolutionary psychologist David Buss suggests that psychology teachers teach the basic tenants of EP early on, and then continue to weave them through the discussion of the various content areas (Parker and Buss, 2006). A good idea would be to try a combination of weaving results from EP throughout coverage of psychology´s sub disciplines, and teaching the basic principles all at once in a separate section of the course. These basic principles should at the very least include the tenants of natural selection, sexual selection, inclusive fitness, and parental investment (Appendix 13).

To make the material more palatable and understandable and to use a lot of animal examples to illustrate the psychological phenomenon they are talking about.

It is important to show how specific testable hypotheses have been developed in particular domains (e.g. mating and aggression), and to present competing hypotheses where they have been advanced. Empirical tests of these hypotheses have been used to adjudicate between competing hypotheses. Buss makes it clear that it is important to include hypotheses that have been falsified, and those that have been robustly confirmed using multiple methods and converging lines of evidence.

Lastly, he reminds teachers that it is important to be up front and straight with your students that there are is considerable evidence that there are dark, and disturbing components of human nature, and that there is strong evidence for differences between men and women in certain domains particularly of mating and aggression.

Liddle and Shackelford (2011) make three important points on teaching EP to students. First, teachers should not give students the false impression that mating is the only topic about which EPs are interested.

Second, EPs should acknowledge and address the controversies surrounding the field, and explain to students why the majority of these controversies arise from fundamental misunderstandings like genetic determinism, teleology, or that EP endorses or promotes behaviors that are immoral.

Third, the greatest challenge of teaching EP is arguably that students must understand and accept as true the theory of evolution by natural selection. It is vital to provide students with the information they need to accept evolution. Some students will refuse to accept it no matter how much time teachers spend explaining it. Therefore, a better strategy might be to encourage students to think critically about the beliefs they hold, and remind them that no beliefs are immune to critical examination.

5.2.3 Why Evolutionary Psychology Is Useful for Psychology

Table 8. Reasons why EP is useful for psychology

1. Provides a casual unifying framework for psychology a. Meta-theory b. Integrates disparate topics, psychological phenomena, and subfields c. An appreciation of the functions of psychological mechanisms 2. Discover undiscovered psychological phenomenon 3. Practical applications to societal problems a. Clinical psychology: Treatment plans b. Jurisprudence: Aid in lawmaking and pubic policy guidelines

Based on Parker and Buss, 2006; Schackelford and Liddle, 2011 and Confer et al., 2010.

According to evolutionary psychologist David Buss there are at least three important implications modern evolutionary theory has for psychology (Parker and Buss, 2006). First, modern evolutionary theory provides a meta-theory for psychological science. Second, EP brings together disparate topics, psychological phenomena, and psychological sub fields by integrating psychology theoretically with the rest of the natural sciences. Third, understanding psychology requires an appreciation of the functions of our psychological mechanisms (Table 8).

Unifying EB and psychology is not all that evolutionary psychologists have been working on. They have even made discoveries of things previously hidden. For example it was not until EPs hypothesized sex differences in evolved design features that such differences were discovered (Buss *et al*., 1992).

One such sex difference in design feature is how men and women weigh different types of jealousy differently. Men are more upset by sexual infidelity because in the ancestral environment in which we evolved a cuckolded men who was not aware that he sired someone else´s offspring would put a large amount of resources in somebody else´s children. Women are more upset by emotional infidelity because in the ancestral environment a woman who would fail to ensure the investment of a man would put her own life and that of her offspring at risk.

EP has even been applied to practical societal problems. Two such applications are seen within clinical psychology and jurisprudence.

Evolutionary oriented clinical psychologists have developed effective treatment for depression based on what plausible mismatches there are between ancestral and modern environments (Confer *et al*., 2010).

Evolutionary oriented legal scholars have used knowledge of evolved psychological adaptations to understand how to better regulate human behavior on the societal level, and used some of the insights EP provide to guide policy decisions (Confer *et al*., 2010).

5.3 Evolutionary Medicine in Medicine

5.3.1 What Evolutionary Medicine Is

EM is the scientific study of addressing problems in medicine using principles from evolutionary biology (Nesse, 2007). Evolutionary medicine integrates complementary views of evolutionary biologists and physicians in the pursuit of increasing our understanding of health and disease (Pearlman, 2013).

Medical researchers with an EM perspective are particularly interesting in knowing why our evolutionary past has left us so vulnerable to disease. These reasons why we are left vulnerable can be grouped into three main categories. The first might be that natural selection is slow, the second is because there might have been constraints to what selection can shape, and the third is that it might have been due to difficulties in understanding what exactly natural selection shapes (Nesse, 2007).

The field of EM covers a wide range of topics and problems: medically significant genetic variation, mismatches of the body to the current environment, issues in reproductive medicine such as short birth intervals and menopause, degenerative disease including the evolution of ageing, and pathogen evolution (Stearns, 2012).

5.3.2 Why Evolutionary Medicine Is Useful to Medicine

Table 9. Reasons why EM is useful for medicine.

1. Expanding evolution´s contribution to existing to existing enterprises that rely on it.
2. Providing a theoretical foundation for epidemiology and public health.
3. Heuristic value: formulating new questions about disease that motivate new studies.
4. Unifying research from different disciplines.
5. Providing a framework for understanding disease from the perspective of evolutionary as well as proximate biology.

Taken from Nesse, 2007.

As the current state of affairs goes, most work in biology is connected to evolution, while most work in medicine is not (Nesse, 2007). The importance of evolutionary biology for medicine is straightforward; medicine is based on biology, and in turn biology is based on evolution. Evolutionary medicine offer useful applications to physicians, but it is far more important that EM offers new research questions and a solid framework for merging medical knowledge about why our bodies are so vulnerable to disease. In sum EM poses new research questions whose answers will likely significantly improve clinical care (Nesse, 2007) (Table 9).

Seen through the eyes of evolutionary medicine the body is a product of the forces of natural selection, which renders the body in some ways aptly built for the environment in which our ancestors lived, but also flawed. As a product of natural selection, the body is littered with all sorts of trade-offs and vulnerabilities that all too often lead to disease. The widespread practice of many physicians to prescribe medications that block our natural responses to disease may be unsafe because those responses might represent the body´s attempt to remedy a problem (Nesse, 2001).

6. Why Students and Staff at Universities Reject Modern Evolutionary Theory

6.1 Defining the Key Parameters for Students´ Belief Formation

The discussion that follows will adhere to Allmonn´s (2011) use of four key terms. By knowledge he means “a proposition or conception that represents what a wider community employs as the best, current description of an aspect of reality in the external world, and for which a learner must have reasons that provide justification or warrant." By acceptance he means "the act or state of agreement that a proposition or conception is true, based on an examination of the plausibility, pervasiveness, and fruitfulness of the empirical support for the construct." By belief he means "a proposition or conception held by an individual to be true, regardless of whether that individual has particular empirical causes for doing so." And by understanding he means "the act or state of comprehending how it is that a particular proposition or conception operates (whether or not it is held to be true) and the linkages and connections amongst its constituent elements or aspects."

6.2 Relation Between Acceptance and Understanding

Rice *et al*. (2015) show that acceptance of biological evolution are positively correlated for university faculty. Higher knowledge of biological evolution positively correlates with higher acceptance of biological evolution across the entire population of university faculty surveyed. Their results support the idea that effective science instruction can have a positive effect on both understanding and acceptance of biological evolution, and that understanding and acceptance are closely tied variables. Specifically, for both measure of knowledge and acceptance of biological evolution, the more science education the participants reported receiving in college, the better they did on those measures.

6.3 The Reasons Why Students Do Not Accept Modern Evolutionary Theory

Kjetland *et al*. (2015) conducted their own survey in 2014 where they interviewed 19 pupils from 1st to 7th grade about the evolution of life. They found out that the students lacked any systematic knowledge in this field. They found that most of the pupils simply just make up their own explanations. They asked the students the same question: "Have humans been on Earth always? The answers they pupils gave could be divided into four categories: those who invoked religious explanations, those that invoked dinosaurs in their explanation, those that invoke evolutionary theory, and those who are confused in their explanation. The authors argue that teachers in middle school have the burden of not only teaching evolution, but also to correct misconceptions (wrongfully preconceived notions) making it very hard to teach in a manner that the material deserve.

The Kjetland *et al*. study receives support for its findings in a review of the literature by Williams (2009), who suggests why people do not believe in evolution is complex, and that it begins with the natural, intuitive development of “creationist” ideas as a very young child. Once this belief is established, is difficult to counter, and may even consolidate reinforcement from close social bonds.

Table 10. Taxonomy of causes of non-acceptance amongst individuals of modern evolutionary theory.

Cognitive reasons

Methodological reasons

Psychological reasons
- Processes that overrule the senses
- Biases of the human mind
    - Essentialism
    - Teleology

Societal reasons
- Religion
- Political orientation (Conservatism)
- School-life expectancy (Education) (Inverse)
- Science literacy (Inverse)
- Gross-domestic product (GDP) (Inverse)

Based on Hessen *et al*. 2009; Thagard and Findlay, 2009; Eve *et al*. 2010; Allmonn, 2011; Heddy and Nadelson, 2012 and Coyne, 2012.

The reasons why adult students and staff at universities reject modern evolutionary theory can be grouped into four broad multi-faceted categories. These are cognitive reasons, methodological reasons, emotional reasons, and political or social reasons (Table 10).

Cognitive reasons include conceptual difficulties students have in adopting population thinking, how students wrongfully conceptualize of species in terms of essences, how species can emerge without direction, and comprehending deep geological time.

Students also have a natural inclination toward purpose-based teleological explanations (Thagard and Findlay, 2009).

It seems that both historically and currently, one of the greatest obstacles to acceptance of evolution is the claim that human thought is a product of it. Students today find that to be among one of the most implausible aspect of Darwin’s theory (Thagard and Findlay, 2009).

Studies in which acceptance is increased by presenting students at universities with a direct comparison of naïve misconceptions of evolution to scientific explanations show that these misconceptions can be real barriers to acceptance of evolution (Allmonn, 2011). Another line of evidence for the importance of education, are several studies that have found that level of education is positively correlated with acceptance of evolution (People for the American Way Foundation, 2000; Brumfiel, 2005).

Methodological reasons arises from how or why the students should come to believe evolution by natural selection. Within philosophy of science there are many contradictory accounts of what would be involved in accepting Darwin´s theory that might make students less likely to accept Darwin´s theory (Thagard and Findlay, 2009). Educators claim that one of the most important causes of non-acceptance of evolution is a ubiquitous lack of understanding of the nature of science. The lack of consensus about what the nature of science actually is, and how it should be taught has important implications for acceptance of evolution (Allmonn, 2011). One consequence of the lack of understanding of the nature of science is that students reject extrapolation from micro- to macroevolution (Allmonn, 2011).

Psychological reasons arise from the fact that students like other people form their beliefs in part by their goals, and not necessarily on the basis of scientific evidence. MET conflicts with some students’ deepest personal beliefs (Thagard and Findlay, 2009).

The psychological factors can be grouped into two categories. (1) Processes that overrule what the senses are telling the mind which leads to decisions counter to the empirical state of the world. (2) Specific innate psychological characteristics and biases in how humans interpret the world around them (Allmonn, 2011).

Two cognitive biases in particular makes scientific explanations for the origins of species more difficult. Those biases are essentialism and teleology. Essentialism is the idea that all living things are separate, stable and unchanging. Teleology is the concept that natural objects have some kind of goal, which is the cause of their functionality (Allmonn, 2011).

Cognitive dissonance theory has been suggested as an explanation for or contributor to a host of human behaviors that go against a rational assessment of available empirical information (Festinger, 1957; Tavris and Aaronson, 2007). Some students try their best to avoid this uncomfortable cognitive dissonance by encountering or honestly engaging with arguments or evidence that evolution is true (Allmonn, 2011).

Societal reasons include political and social factors that can influence individuals directly, or by providing an environment in which other factors act. Students' political orientation is nearly as powerful as education in predicting MET acceptance, at least in the US (Minõ and Espinosa, 2009; Allmonn, 2011; Coyne, 2012).

Both historically and currently religiosity is considered by education researchers as one of the most important reasons for non-acceptance of evolution. Specifically, evolution appears to call into question the literal truth of religious scriptures. Though scientists debate over the compatibility of science and religion, some of them have argued in favor of accommodation, and claimed that students´ resistance to evolution might lessen (Hessen *et al.*, 2009; Allmonn, 2011; Heddy and Nadelson, 2012).

6.4 How Students Perceive of Modern Evolutionary Theory

Brem *et al*. (2002) examined how college-educated adults from diverse ethnic and religious backgrounds perceive the impact of evolutionary theory on individuals and society. The authors focused on college students at a public university, and measured perceived impact in five areas: sense of purpose in life, perceptions of race and ethnicity, sense of spirituality, perceptions of selfishness and sense of self-determination. Both creationists and evolutionists viewed the consequences of accepting evolutionary principles in a way that might be considered undesirable: increased selfishness and racism, decreased spirituality, and a decreased sense of purpose and self-determination.

7. Persuading Students to Accept Modern Evolutionary Theory

7.1 Why Persuading Students and Staff to Accept Modern Evolutionary Theory Is Important

Williams (2009) argues there are several reasons why it is important to persuade students and staff of the truth of modern evolutionary theory. First, biological evolution is the unifying concept of the biological sciences. Second, modern evolutionary theory explains how our bodies are subject to natural selection, and how physicians utilizing insight from the emerging field of evolutionary medicine can more effectively deal with pathogens and disease. Third, understanding faculty personal´s acceptance and understanding of biological evolution, will allow science educators to answer important questions about Biological Evolution Education. Fourth, university faculty outside the biological sciences may influence other faculty and students as well as post-secondary students (i.e. ripple effect).

7.2 How to Persuade Students to Accept Modern Evolutionary Theory

Table 11. Tips and guidelines for how to persuade students to accept modern evolutionary theory at university and college.

1. Teach elementary concept of MET to pupils in primary school.
2. Provide up-to-date, high quality teaching material.
3. Teach about NOS.
4. Avoid inappropriate and inaccurate language.
5. Take advantage of teaching outside the classroom.
6. Address the challenges religion faces head on.
7. Move from conflict to conversation in the classroom.
8. Create engaging material by focusing on human evolution.

Compiled from Hessen *et al*., 2009; Thagard and Findlay, 2009; Williams, 2009 and Pobiner, 2016.

Williams (2009) suggests that in order to defeat creationism and ID it is vital to ensure that evolution instruction is at the heart of biology teaching, and that several steps should be taken to make that happen. (1) Policy-makers and curriculum developers must begin to teach some elemental concepts of modern evolutionary theory in primary schools. (2) Science textbooks and other resources should provide better, more up-to-date examples of evolution. (3) Teachers should be given tools to combat creationist and ID arguments in the classroom. (4) The community of science teachers should come to a consensus on the definitions of key terminology associated with NOS. (5) Scientists should avoid inappropriate and inaccurate language such as design-related terminology, especially in the classroom. Allmonn (2011) make some additional suggestions to enhance the teaching of evolution in school. (1) More research on why and when different people accept or do not accept evolution when they are exposed to it. (2) Increased application of approaches to evolution education in settings outside the K-16 classroom (Table 11).

As stated previously, one of the most challenging aspects of teaching modern evolutionary theory is how to deal with religious students, and religion in certain areas of teaching Darwin´s theory. Thagard and Findlay (2009) suggest three main approaches to teaching and dealing with this problem: detachment; evolution and other biological theories are discussed with no mention of the problems that arise from religious issues, reconciliation; argue science and religion are compatible, and confrontation; argue that religion and science are in conflict with each other. Which of these strategies is best for science education depends philosophical, scientific, psychological and political factors.

In a comprehensive review by physical anthropologist Briana Pobiner (2016) several suggestions for how to teach modern evolutionary theory effectively to students were outlined. She suggests four main guidelines to teachers of modern evolutionary theory, and how to implement them.

She suggests moving from conflict to conversation in the science classroom, and teach evolution material that is up-to-date, authentic, and stimulating content for classes. Teachers feel they could be more effective in teaching evolution if they had access to: the most up-to-date information about evolution and genomics, richer evolution lesson plans that include not only science, but personal stories on how the lessons arose, and a safe space in which to relate on the possible personal and social implications with their peers.

Research has identified a relationship between anti-evolution attitudes and several misconceptions about the nature of science in teachers and students. There is a positive correlation between science literacy and acceptance of evolution at various resolutions of analysis. Students should have adequate, meaningful, and substantial exposure to science, and scientific practices in education. Aspects of the nature of science that have been identified as vital for increasing understanding of evolution include among many others: the empirical nature of science, the methods of scientific testing, and the role of observation in science.

She proposes that the experiences children have prior to their earliest explicit evolution learning experience are very important for influencing how students can develop acceptance and understanding of evolution. She suggests teaching evolutionary concept to pupils in elementary school.

Helping students make connections between modern evolutionary theory and personal experiences or real-world examples. Using human examples may be beneficial because it might students overcome some of the conceptual barriers to understanding evolution. These examples of evolution related to humans should focus on current topics and everyday experience to highlight the relevance and applicability of evolutionary theory.

8. Summary of Chapter 2

MET is an invaluable addition to the curriculum of biology, medicine and psychology because it provides a unifying casual framework for how to understand the discipline in light of our evolutionary history, and the forces that shaped us.

Some students and staff at universities and colleges reject MET due to a host of factors, some effecting students and staff early in their life, some effecting them later. Reasons students and staff reject MET in their adults life include cognitive reasons such as adopting the particular way that biologists think, and overcoming the disbelief that many aspects of humans are a product of evolution. Methodological reasons are especially related to the nature of science, and the fact that many students and staff have trouble in figuring out what exactly it entails to accept evolution. Psychological reasons include a myriad of ways our human minds harbor biases and other failures of thinking that makes people less able to rationally evaluate empirical evidence and arguments. And finally students and staff might be less willing to accept MET if they live in a society where certain factors are present, namely high religiosity, low school-life expectancy, low gross-domestic product, and low levels of science literacy.

Though teaching evolution and biology to students is not an easy task, and some students will probably never change their mind regardless, research give some guidelines for how to most effectively teach MET, and thereby increase the chances for students to accept evolution. Some of these advices include providing an engaging and non-hostile classroom environment, to start instruction of evolution in primary school by teaching the most basic concept, to focus on human evolution, and to not shy away from discussion religious matters in an effort to understand where the students are coming from. More research on the non-acceptance of evolution, and the effectiveness of certain teaching methods may also provide useful.

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11. Appendix

Overview

11.1 The Online Survey.

11.2 Description of the Universities.

11.3 The I-SEA Survey Questions.

11.4 Poster.

11.5 Application to Norwegian Social Science Data Services.

11.6 Approval from Norwegian Social Science Data Services.

11.7 Supplemental Material: Demographics

11.8 Supplemental Material: Games Howell post hoc test.

11.9 Supplemental Material: Explanatory variables.

11.10 Supplemental Material: Effect sizes.

11.11 Mini Review of Incentives.

11.12 Supplemental Material Table from Rice *et al*., 2015.

11.13 Supplemental Material: Example syllabus of EP course.